Infancy and Toddlerhood

5 • Physical Development in Infancy and Toddlerhood
6 • Cognitive Development in Infancy and Toddlerhood
7 • Social and Emotional Development in Infancy and Toddlerhood
Test your knowledge of child development by deciding whether each of the following statements is true or false, and then check your answers as you read the chapter.

1. T □ F □ Humans use only 10% of their brains.
2. T □ F □ Infants are born with almost all the brain cells they will ever have.
3. T □ F □ Newborn babies form synapses (the connections between nerve cells) in their brains at the rate of a hundred new connections each second.
4. T □ F □ Babies are unable to see when they are first born.
5. T □ F □ Infants are born with a preference for the foods common in their culture.
6. T □ F □ Within the first 2 months of life, infants do not experience pain.
7. T □ F □ Babies triple their birth weight by the time they are 1 year old.
8. T □ F □ It is important that infants crawl before they walk. If they go directly to walking, they are more likely to develop learning disabilities later in life.
9. T □ F □ Potty training most often becomes a battle of wills between a toddler and her parents.
10. T □ F □ Baby walkers help babies walk at an earlier age.

Correct answers: (1) F (2) T (3) T (4) F (5) F (6) T (7) T (8) F (9) T (10) F

Copyright ©2015 by SAGE Publications, Inc. This work may not be reproduced or distributed in any form or by any means without express written permission of the publisher.
In this chapter, we open our study of infants and toddlers by examining some of the central issues regarding their physical development. We begin by looking at the infant brain and how it develops (including some information on disabilities associated with brain development). We then describe how infants’ senses develop and how they predispose babies to form social relationships. We look at how infants’ bodily proportions are different from those of adults and examine how infants and toddlers develop gross and fine motor skills during the first 2 years of life. We also explore issues of health and nutrition, including breastfeeding, sleep, illnesses, and infant mortality and child abuse. We conclude by examining the effects of stress on physical and emotional well-being.

Brain Development

Brain development begins prenatally, and by the time a baby is born, all the basic structures of the brain are in place. But, as we are about to see, infancy is a time when there is rapid growth and change in the young brain, just as there is rapid growth throughout the rest of the body.

We begin our discussion of brain development by addressing two common misconceptions. The first is the myth that humans use only 10% of their brains. As we describe the parts and the functions of the brain in the following sections, it should become clear to you that we use all parts of our brains. Neurologist Barry Gordon, who studies the brain, says, “It turns out... that we use virtually every part of the brain, and that [most of] the brain is active almost all the time” (Boyd, 2008, para. 5). The second misconception is that what we think has little to do with how our bodies function, and that our body’s functioning has little to do with our thoughts. In fact, what affects the brain affects the body, and what affects the body affects the brain (Diamond, 2009). To begin to see the surprising ways in which the brain and the body interact, try Active Learning: Brain and Body.

Active Learning

Brain and Body

Sit comfortably in a chair. Cross your right leg over your left (at the knee or ankle). Circle your right foot to the right (in a clockwise direction). Now, using your right hand, draw a number 6 in the air. Were you able to keep your foot circling to the right? A few people can, but most people cannot. This is easy to do using your right foot and your left hand, so the difficulty arises from the fact that the left side of your brain controls the right side of your body and seems to be able to direct movement in only one direction at a time. You know your body is physically capable of doing both actions, but your brain may not let you do both at the same time. Children too are limited in their physical abilities, in part because of their brain development. Not only will you be learning about the impact of the brain on the body’s activities in this chapter, but you will also learn about the impact the body has on the brain and the effect that experience has on the development of both body and brain.

Learning Questions

5.1 What are the structures of the brain and related developmental processes and disabilities?
5.2 How do the five senses develop in infancy and toddlerhood?
5.3 What reflexes and motor skills do infants and toddlers possess?
5.4 What are the major health and nutrition issues in infancy and toddlerhood?

5.1 What are the structures of the brain and related developmental processes and disabilities?
T/F #1
Humans use only 10% of their brains. false
Structures of the Brain

The brain is an organ of the body made up of a number of different parts. We can examine it from two perspectives: from side to side and from back to front. As you can see in the photo shown here, the brain is divided down the middle into two halves, or hemispheres. Some parts of the brain are found on both sides, and some are located in only one hemisphere. For example, the motor cortex that controls the body’s movements is similar on both sides, but only the right side of the brain controls the left side of the body, and vice versa. However, the language centers of the brain appear largely on the left side, at least for right-handed people. Lefties may have their language centers on either or both sides. The two sides of the brain communicate with each other through a band of fibers that connects them, called the corpus callosum.

Although the two sides have some distinct functions, there is no such thing as being totally “right-brained” or “left-brained.” Both halves of our brains are involved in complex ways in almost everything we do. For example, although much of language is processed on the left side, specific aspects, such as humor and the emotional tone of what we say, are processed in the right hemisphere (Kinsbourne, 2009).

We get a different view of the brain when we look at it from the side. The parts, or lobes, of the brain have some distinct functions, which we describe below. However, as we saw with the two hemispheres, it is important to realize that most aspects of human functioning engage many parts of the brain in coordination with one another. For example, the occipital lobe is known to control vision, but the parietal, temporal, and frontal lobes also play a role in vision (Merck Manual, 2008).

Look at Figure 5.1 along with Table 5.1, to identify the parts of the brain in this image, working from the back of the head (on the right side) toward the front (on the left side). Starting at the lower back of the head, the brain stem (in blue) includes the spinal cord, which controls our basic functions such as breathing. Next, the cerebellum (in green) controls balance and movement. Above the cerebellum, the cerebrum or cortex controls the higher functions of thought and action. The cerebrum includes many different parts, including the occipital lobe (in yellow), which processes vision; the temporal lobe (in pink), which processes hearing; the parietal lobe (in orange), which processes sensory input and spatial awareness; and the frontal lobe (in red), which processes complex thoughts, movement, language, and self-control. The very front of the cerebrum is called the prefrontal cortex, and it controls judgment and the ability to plan. Within the cerebrum, but not visible in Figure 5.1, are the amygdala and the hippocampus, which are important in the experience and expression of emotions, memories, and sensations (Bear, Connors, & Paradiso, 2007).

Although this is a good description of some of the functions that we currently know are associated with different areas of the brain, brain research is one of the most active areas in the field of child development, so our understanding of brain functions will undoubtedly change as research continues. As we continue our discussion of the brain, think about how different aspects of physical development are linked back to the different parts of the brain and the functions they control. In future chapters you will learn more about the cognitive, language, and emotion centers of the brain and their functions.
Developmental Processes

The infant brain grows and develops through the interaction of biological forces and environmental influences. This process directs the way the cells of the brain connect with one another and the pattern of connections relates to many aspects of physical, cognitive, and social-emotional development.

Neurons and Synaptic Connections

The adult brain and nervous system is made of 100 billion nerve cells, called neurons (Pakkenberg & Gundersen, 1997). Each nerve cell sends nerve impulses via special chemicals called neurotransmitters to other nerve cells. As you can see in Figure 5.2, each cell sends neurotransmitters through extensions of the cell called axons and receives messages through receptors called dendrites. Axons are the part of the nerve cell that conducts impulses away from the cell body, and dendrites are the parts that receive impulses from other neurons. The place where the axon from one neuron meets the dendrite of another neuron is called the synapse. Just about everything we do depends on communication between nerve cells. Adults have approximately 1 quadrillion (!) of these synaptic connections.

Infants are born with almost all the neurons they will ever have; however the synapses or connections between them are largely formed after birth. As a result, babies have fewer inborn behavior patterns than other animals, and they are more open to learning from their environment. The experiences they have actually shape the development of synaptic connections and the formation of their brains (Rosenzweig, Breedlove, & Watson, 2005). The development of new synapses is referred to as synaptogenesis. After a baby is born, new synapses may be formed at the rate of more than one million connections per second (Greenough, Black, & Wallace, 1987). One reason infants’ brains are more active than adults’ is that they are so busy forming connections (Gopnik, Meltzoff, & Kuhl, 1999).

<table>
<thead>
<tr>
<th>Name of Structure</th>
<th>Color in Figure</th>
<th>Some Functions of Each Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain stem</td>
<td>Blue</td>
<td>Includes the spinal cord, which controls basic functions such as breathing, heartbeat, and blood pressure</td>
</tr>
<tr>
<td>Cerebellum</td>
<td>Green</td>
<td>Controls balance and movement</td>
</tr>
<tr>
<td>Occipital lobe</td>
<td>Yellow</td>
<td>Processes visual information</td>
</tr>
<tr>
<td>Temporal lobe</td>
<td>Pink</td>
<td>Active in hearing, language, memory for facts, visual memory, and emotion</td>
</tr>
<tr>
<td>Parietal lobe</td>
<td>Orange</td>
<td>Processes sensory input and spatial awareness</td>
</tr>
<tr>
<td>Frontal lobe</td>
<td>Red</td>
<td>Processes complex thoughts, movement, language, working memory, and self-control</td>
</tr>
</tbody>
</table>

**TABLE 5.1** Brain structures and functions


**T/F #2** Infants are born with almost all the brain cells they will ever have. **True**

**T/F #3** Newborn babies form synapses (the connections between nerve cells) in their brains at the rate of a hundred new connections each second. **False**

**Neurons** The cells that make up the nervous system of the body.

**Neurotransmitters** Chemicals that transmit nerve impulses across a synapse from one nerve cell to another.

**Axon** The part of a nerve cell that conducts impulses away from the cell body.

**Dendrites** The parts of a neuron that receive impulses from other neurons.

**Synapse** The place where the axon from one neuron meets the dendrite of another neuron.
The ability of the infant brain to change in form and function is referred to as **plasticity**. If you, as an adult, had half your brain (one hemisphere) removed, the result would be catastrophic. You would lose movement in the opposite side of your body, and you would lose the functions handled in that hemisphere. For example, people who have damage to the language centers in the left hemisphere may be unable to speak. However, until about age 4 or 5, children who have had one hemisphere removed to treat an otherwise untreatable condition, such as severe epilepsy, can recover almost full function (Eliot, 1999).

In one study of children who had an entire temporal lobe removed, there was no significant decline in the group’s overall IQ following the surgery (Westerveld et al., 2000). Even when the surgery removed the left temporal lobe (the part of the brain associated with language), there was no loss of verbal intelligence and nonverbal intellectual functioning actually improved significantly. This occurs because the brain at this young age has enough plasticity that brain cells originally intended to serve one function (for example, controlling movement) can turn into cells that control another function instead (for example, language). In the study by Westerveld et al. (2000), the small group of children who experienced significant loss of function following the surgery tended to be the oldest in the group.

At various times within the first years of life, babies’ brains produce so many new synaptic connections that the density of connections is greater than that found in the adult brain (Blakemore & Choudhury, 2006). However, in the normal process of brain development, many of these synaptic connections do not survive. In a process called **pruning**, synaptic connections that are used remain, and those that are not used deteriorate and disappear.
disappear. Just as pruning dead branches strengthens a tree, pruning unused synapses strengthens the brain. Rather than being a terrible loss, this process results in a brain that is much more efficient (Huttenlocher, 1999). As an example, newborn infants can distinguish between speech sounds found in all languages, but during their first year of life they are exposed only to the specific sounds in the language that they hear each day. By one year of age, they can no longer distinguish between sounds found in other languages they don’t regularly hear. This fine-tuning of the ability to categorize sound is thought to be the result of pruning of synapses in the part of the brain that processes sound during early development (Blakemore & Choudhury, 2006).

The process of pruning follows a “use it or lose it” principle. Greenough et al. (1987) described two ways this happens: experience-expectant mechanisms and experience-dependent mechanisms. Experience-expectant brain development occurs because our brain encounters experiences that it expects to happen. For example, in the normal course of events our eyes will be exposed to light. When these expected events occur, the pathways in the brain that are used are retained. In experiments with kittens, Hubel and Wiesel (1965) showed that if this does not happen, the eye still develops normally, but the part of the brain that processes visual information does not function. Kittens with one eye closed for a period of time after birth were never able to develop vision in that eye, even when it was later open. This is why children who have an eye that has considerably less vision or doesn’t coordinate with the other eye (a condition called amblyopia or “lazy eye”) must have intervention early in their lives or they may lose effective vision in that eye.

Experience-dependent brain development is much more individual and depends on each person’s particular experiences. In addition to unused synapses being pruned away, it appears that new synapses develop in response to stimulation. For example, Elbert, Pantev, Wienbruch, Rockstroh, and Taub (1995) studied the brains of violinists. If you pretend to play the violin, on which hand are the fingers more active? The fingers of your left hand move all around, pressing on the strings to produce different notes, while the fingers of your right hand usually stay in one position, holding the bow. Elbert et al. (1995) found that in violinists the area of the right side of the brain that controls the left hand had many more synaptic connections than the same area of the left side of the brain. It is unlikely that these people are born this way, making them more likely to become violinists. Instead, the constant use of the fingers of the left hand to move and press the appropriate strings on the violin further develops that part of the right side of the brain.

Myelination of Neurons in the Brain
So far we have discussed the development of synapses through the process of synaptogenesis, but for messages to be sent successfully, myelination, another process in the development of the nervous system, is necessary. For neurons to work efficiently, they need to be coated with a fatty substance known as myelin, as shown in Figure 5.3.

Picture an electrical cord between the wall socket and your lamp. How does the message travel from the light switch to turn on the lamp? Within the electrical cord is a metal wire that carries the electrical current. If bare wire were used with no insulation, not only would you get a shock when you touched it, but your light would not work very well. Only some of the current, not all of it, would be likely to arrive at its destination. For that reason, an electrical cord is always insulated with some material that cannot carry an electric current. As a result the electrical message all goes to turn your light on. In a similar fashion, the neurons in the nervous system are insulated with myelin so the message sent by the neurotransmitters will be received most effectively.

When babies are born, just as the synaptic connections are not complete, so too the myelin sheath does not yet cover all the neurons in the nervous system. The process of producing synaptic connections, pruning away those that are not being used,
and myelinating the connections that are left begins in infancy and continues throughout childhood and adolescence (Paus et al., 1999). We have only recently developed imaging techniques that can trace the developmental pattern of myelination in the human brain as it proceeds from the lower centers at the base of the brain through the higher centers of the cortex (Deoni et al., 2011). As researchers learn more about the normal progression of myelination, they are also likely to find evidence of the abnormal processes that may underlie such disorders as autism and schizophrenia (Deoni et al., 2011).

We have already learned that synaptogenesis is affected by our experiences through the process of experience-dependent brain development. There is also evidence that myelination is affected by our experiences. Bengtsson et al. (2005) compared brain development in children who spent long hours practicing piano to that in children who did not play piano. Their evidence indicates that the extra stimulation certain neurons experience when children are practicing results in more myelination of those neurons, including those in the corpus callosum, which connects the two hemispheres of the brain. The corpus callosum assists your ability to coordinate movements of your two hands at the same time. In this study, children who played piano had increased brain efficiency, and this increased ability continued into adolescence.

**Disabilities Related to Brain Development**

When brain development does not occur as expected, or when there is damage to the brain at any point, a number of disabilities may result. We discuss cerebral palsy here because specific brain abnormalities are known to cause this disability. We also include autism in this section because brain development has been linked to the development of this disorder, although the exact mechanism remains to be discovered.

**Cerebral Palsy**

Cerebral palsy is an umbrella term that describes a group of brain-based disorders that affect a person’s ability to move and maintain balance and posture. People with cerebral palsy may experience difficulties with muscle tone, coordination, movement, and speech. These abnormalities arise early in development and are the result of brain injuries that can occur during fetal development or at any point up to about 3 years of age (Abdel-Hamid, 2011). About 70% of cases of cerebral palsy result from brain injury during prenatal development, most often with no known cause, and an additional 10% to 20% are due to brain injury during the birth process itself (United Cerebral Palsy, 2007). The remaining cases occur after the infant is born but early in development, when an infection or injury causes damage to the brain. Approximately 800,000 children and adults in the United States live with one or more symptoms of cerebral palsy (National Institute of Neurological Disorders and Stroke [NIHDS], 2011a), and the percentage of children afflicted by this condition has remained largely unchanged over the past 30 years (Abdel-Hamid, 2011).

Risk factors include premature birth, low birth weight, conception of two or more fetuses, maternal exposure to toxins or infections, and lack of oxygen during the birth process (Abdel-Hamid, 2011). While some children are profoundly affected and will need total care throughout their lives, others show only mild impairment and require
little or no special assistance. Although this condition does not worsen with age, early intervention and therapy can be beneficial to the child because it can help prevent or delay the onset of secondary problems. The goal of intervention is to create an individual treatment plan that meets each child’s unique needs. Medications can help control seizures and muscle spasms, surgery can lengthen muscles and tendons that are too short to function, and physical therapy can help the child build necessary skills. You also may have seen new technologies that let children with cerebral palsy use even limited head movements to operate a computer with a voice synthesizer that enables them to communicate.

An exciting new avenue of research is investigating the use of a drug that allows regrowth of the myelin coating on nerve cells in the brain (Fancy et al., 2011). When a lack of oxygen disrupts the nerve cells’ ability to create myelin, those cells die, which can lead to cerebral palsy. Although far from being ready to use in humans, this research offers hope for a new pharmaceutical treatment of this type of brain injury.

**Autism Spectrum Disorder**

Autism spectrum disorder (ASD) includes a range of symptoms that can vary greatly in severity from one child to the next. ASD is characterized by pervasive impairment in social communication and interaction and by restricted or repetitive behaviors, interests or activities (American Psychiatric Association, 2013). Severity is classified in the Diagnostics and Statistics Manual-5 (DSM-5) of the American Psychiatric Association by how much support the individual needs to function effectively. Some children with autism have few words and respond only to very focused, direct approaches from other people, while those with less severe symptoms may speak normally, but are not successful at maintaining the normal back and forth of conversation (American Psychiatric Association, 2013). Research is ongoing about the ways in which brain structure and function underlie the symptoms of ASD. In young children with ASD, imaging has shown enlargements of certain parts of the brain, in particular the amygdala, which is active in emotional experience and expression. This research found that the larger the amygdala, the more difficulty the person has with social relationships (Sparks et al., 2002).

For children with ASD the brain may have too many synapses in certain areas. Instead of having efficient, strong connections among specific neurons, they have less efficient connections among many more neurons (Shih et al., 2011). You can see this illustrated in Figure 5.4. We do not yet know whether the brains of children with ASD produce an overabundance of synapses, or whether the normal number of synapses are not pruned away as they should be.

Although we typically don’t label a child as autistic until he or she is 3 years or older, there is a growing body of evidence that symptoms of autism are apparent earlier in development (Kalb, 2005; NIMH, 2009b). In one recent study researchers found that...
infants who were later diagnosed with ASD began to decrease their attention to other people's eyes beginning at two months of age (Jones & Klin, 2013). If other researchers confirm this new information, we might be able to begin intervention even earlier than we can now. Current methods can make valid and reliable diagnoses as early as 18 months (Chawarska, Klin, Paul, & Volkmar, 2007; Lord, Risi, DiLavore, Shulman, Thurm, & Pickles, 2006), and new tests for infants as young as 12 to 18 months are being developed. For instance, research has shown that the brains of typically developing infants respond differently when they see faces than when they see objects, but in infants with ASD, the brain does not seem to differentiate faces from objects (McCleery, Akshoomoff, Dobkins, & Carver, 2009). This may relate to the tendency of individuals with ASD to avoid looking at other people's faces.

The Centers for Disease Control (2010a) recommend screening infants for developmental delays that might indicate the presence of an ASD at well-baby checkups throughout the first 2.5 years of life. Table 5.2 shows some of the behaviors that health care providers may check for during the first 2 years.

**TABLE 5.1 Infant screening for autism spectrum disorders**

Some behaviors in infancy that are possible indications of autism include:

- child does not babble or coo by 12 months of age
- child does not gesture, such as point or wave, by 12 months of age
- child does not say single words by 16 months
- child does not say two-word phrases on his or her own (rather than just repeating what someone else says) by 24 months
- child has lost any language or social skills (at any age)
- child does not establish or maintain eye contact
- child does not make facial expressions or respond to your facial expressions
- child does not respond to his name by 12 months of age

**SOURCE:** WebMD (2013).
There is good reason to identify this condition as soon as we can because the optimal intervention consists of at least 2 years of intensive intervention during the preschool years (Filipek et al., 1999; NINDS, 2008). Although there is no cure, such early intensive behavioral intervention has brought about substantial improvement in IQ and adaptive behavior (skills needed for everyday life) for many autistic children. Intensive early intervention also has improved the ability to discriminate faces from objects and many other behaviors associated with ASD (Dawson et al., 2012). Results are less clear so far for language and social development (Reichow, 2012).

Because ASD has a strong genetic component, not all children will eventually benefit from early intervention, but we do not yet know who will benefit and who will not, so it is important that all children take part in treatment as soon as they are diagnosed. Because the plasticity of the infant brain allows for growth and change, there is hope of an improved outcome for children with ASD (Dawson, 2008).

Check Your Understanding

1. What are the roles of neurons and synapses?
2. What happens in the process of pruning?
3. What role does myelination play in brain development?

Sensation and Perception

Infants use the information that comes to them through their senses to learn about the world in which they live. In the next section, we describe how the development of the brain and the senses promotes learning and also predisposes babies to form the all-important attachments to their caregivers.

When we talk about sensations, we are referring to the information from the environment that is picked up by our sense organs. For instance, light from the environment stimulates the retina of the eye, sound waves stimulate the auditory nerves in the inner ear, and chemical compounds in the food we eat stimulate the taste receptors on our tongue. However, it is the brain that puts the sensory information that it receives together so that it can interpret what is happening in the world and attach meaning to that information. This is the process of perception. For example, light within a certain range of wavelengths is the color red and within another range of wavelengths is the color blue. But when the retina of your eye is stimulated with the wavelength for red, it is the process of perception that interprets the wavelengths as color. Before we discuss development of the five senses, we begin this section by describing a special way in which our senses link us to other human beings.

Mirror Neurons

Newborn babies are capable of imitating adults’ simple facial expressions (Meltzoff & Moore, 1997). If you stick out your tongue at a baby, the baby may stick her tongue out at you. Until recently, scientists had little idea how infants were capable of manipulating parts of their body they can’t even see, but in the 1990s, a team of Italian researchers was studying the brains of macaque monkeys when they discovered what are now called mirror neurons (Winerman, 2005). The researchers found that the same neurons fired whether the monkey put something in its own mouth or saw the researcher put something in the researcher’s mouth. Although the exact neurons that perform these functions have not yet been found in humans, results from brain imaging studies indicate that for humans the same regions are activated for both experienced and observed motor movement and emotional expression. For newborns, this built-in system may activate an
automatic imitative response. Just as we automatically cringe when we see a baby cry in response to an injection, or open our mouths as we feed babies, or laugh when we hear others laugh, babies also imitate some of our actions automatically. This is a powerful way in which babies are brought into the social world. They learn from us, and we enjoy seeing ourselves reflected in our babies. By contrast, when autistic children were shown pictures of faces expressing a range of emotions and were asked to imitate those faces, there was less activity in the brain regions associated with mirror neurons than in children without autism. Further, the more severe the child’s condition, the lower the level of neural activity (Dapretto et al., 2006). This imitative deficit may contribute to the social isolation we associate with autism.

You know that yawns are contagious because you see it happen in classrooms all the time. When we see someone else yawn, think about yawning, or even hear the word “yawn,” 40% to 60% of us will yawn (Platek, Critton, Myers, & Gallup, 2003). In a study in which researchers measured and mapped brain activity using functional magnetic resonance imaging (fMRI), they found that when adults saw a video of someone yawning, a certain area of the brain associated with the mirror neuron system was activated (Haker, Kawohl, Herwig, & Rössler, 2013). This involuntary “matching” of our behavior to another person’s behavior is one way we show that we are in sync with others during our social interactions. Helt, Eigsti, Snyder, and Fein (2010) examined how the tendency to mimic behavior changed as a function of a child’s age and explored whether it differed between typically developing children and children with autism spectrum disorders. They found that if an experimenter yawned four times while reading a book to young children, 10% of 3-year-olds, 35% of 4-year-olds, and 40% of 5- and 6-year-olds would also yawn on at least one of those occasions. However, children with autism spectrum disorders were significantly less likely to yawn under the same conditions, regardless of their age. You can see for yourself how we mirror the behavior of others by completing Active Learning: Contagious Yawning—Mirror Neurons at Work.

**Active Learning**

Contagious Yawning—Mirror Neurons at Work

Ask to read a short story to a child between the ages of 2 and 7 years. Because older children may be reading themselves and don’t still expect to be read to, tell the child you want to ask some questions after the story. Sit across from the child so she can easily see what you are doing, and yawn 4 different times during the story, watching to see whether the child mirrors your behavior by yawning herself.

Either try this with several children of different ages, or pool your findings with those of others in your class to see whether your results resemble the age-related findings of Helt and colleagues. Remember to ask a few simple questions about the story at the end and thank the child for listening.

Keep in mind that in the research by Helt et al. (2010) the majority of children at all ages do NOT yawn, so do not think that there is something wrong with the child you are observing if he or she does not yawn when you do.
Development of the Five Senses

Why do infants look us in the eye? How is it that they recognize their mother’s voices? These and other abilities that foster infants’ relationships with others result from the rapid development of the five senses in the early weeks and months of life.

Vision

Infants are able to see from the time they are born although their vision is much weaker than normal adult vision. Young infants’ visual acuity, the ability to see things in sharp detail, is about 20/400, which means an infant can clearly see at 20 feet what an adult with normal vision can see at 400 feet (Balaban & Reisenauer, 2005). Until they are about 3 months old, infants focus on objects that are 8 to 10 inches in front of them (American Optometric Association, 2013). That is one reason we often put our faces close to infants when we are talking to them—they don’t see us clearly until we get that close. Infants will not develop adult levels of visual acuity until sometime between 6 months and 3 years (Slater, Field, & Hernandez-Reif, 2007).

However, infants can see faces, and from birth they are attracted to the faces of people around them, especially their mothers (Farroni, Menon, & Johnson, 2006). In addition, they tend to concentrate on areas of high contrast—that is, where darkest dark meets lightest light. At first this may mean they scan the parent’s hairline, but at 2 months of age, infants concentrate attention on the eyes, where the white of the eye surrounds a darker center (Ramsey-Rennels & Langlois, 2007).

Think about how you would feel when holding a baby who looks you directly in the eye. Many parents respond with a sense that “this baby knows me.” Haith, Bergman, and Moore (1977) have argued that babies are responding to social stimuli, not just high contrast, because their research showed that babies focused more on their mothers’ eyes when their mothers were talking than when they were silent. If high contrast were the only factor, the child would pay equal attention to the eyes whether the mother was talking or not. More recently, Farroni and her colleagues (2006) found that newborns look more at the face of a person who is gazing directly at them than at the face of someone who is looking away. However, regardless of whether this is a “trick of nature” or a true social response, the fact that babies tend to look us in the eye is surely an adaptive way they attract others to interact with them. In fact, research has shown that mothers are more likely to continue to interact warmly with their infants when they are looking their mothers in the eye (Haith et al., 1977).

Hearing

Hearing becomes functional while the fetus is still in the womb, and one sound fetuses hear loudly is their mother’s voice. Subsequently, babies show a preference for their mother’s voice within the first 3 days of life (DeCasper & Fifer, 1987). Although they don’t know the meaning of the words, they even remember the specific sounds
the mother said if she repeats them regularly while she is pregnant. In a famous experiment, mothers were assigned a story such as The Cat in the Hat to read aloud twice a day to their unborn fetus during the last 6 weeks of their pregnancy (DeCasper & Spence, 1986). Within hours of their birth, the newborns were given a special pacifier. If the infants sucked on the pacifier in a certain way, they heard a recording of either their mother or another woman reading the assigned story, but if they sucked in a different way they heard a recording of a different story. The researchers concluded that babies showed memory for what they had heard prenatally because they were more likely to suck the pacifier in the way that produced the recording of the story they had heard prenatally.

What else do babies hear prenatally? To get a little bit of an idea, press your ear against another person’s stomach (choose someone you know well!). What sounds do you hear? Babies hear all this and more: the mother’s heartbeat and sounds of digestion, as well as talking and other outside sounds. In fact, many babies seem to need a certain level of noise in their first few months after birth in order to sleep. Many parents resort to leaving a vacuum cleaner running or putting the baby near a running clothes dryer to provide a level of background sound. Teddy bears with built-in “heart sounds” also can help soothe babies.

Smell

Babies know their mother’s smell from very early in their lives. Within the first 6 days of life, they will turn toward their mother’s smell more often than toward another mother’s scent (MacFarlane, 1975), and research has shown that babies who are being breastfed recognize their mother’s scent in the first weeks of life (Cernoch & Porter, 1985; Vaglio, 2009). This may be linked to a similarity between the smell of the amniotic fluid they experienced before birth and the smell of the mother’s breast milk (Marlier, Schaal, & Soussignan, 1998). Babies are even soothed by the scent of clothes their mother has been wearing (Sullivan & Toubas, 1998).

Taste

Infants prefer sweet tastes and react negatively to salty, sour, and bitter tastes (Rosenstein & Oster, 2005). Mother’s milk is sweet, so this draws the baby to the food and to the mother. This taste preference has been used to help infants who must undergo a painful procedure: baby boys sucking a sweet pacifier while undergoing circumcision cried less than those who used an unflavored pacifier (Blass & Hoffmeyer, 1991). Mother’s milk, as well as amniotic fluid, takes on some of the flavor of the foods the mother eats (Fifer, Monk, & Grose-Fifer, 2004). Therefore, babies are introduced to the tastes of their local foods even before birth, and there is evidence that early experience with particular tastes becomes acceptance or preference for such tastes later in life (Mennella, Griffin, & Beauchamp, 2004).

Touch and Pain

Touch can be very soothing. In one study, babies who were held in skin-to-skin contact with their mothers cried less when given a slightly painful medical procedure (in this case, a heel stick to extract a small amount of blood) (Gray, Watt, & Blass, 2000). As we
discussed in Chapter 4, Tiffany Field and her colleagues at the Touch Research Institute at the University of Miami have found that infant massage improves growth and effectively soothes babies of all ages, even premature babies (Dieter, Field, Hernandez-Reif, Emory, & Redzepi, 2003; Field et al., 2004). Many adults who have had a massage know how relaxing it can be. Massage with children can be helpful in improving conditions that range from anxiety (Field et al., 1992) to HIV (Diego, Hernandez-Reif, Field, Friedman, & Shaw, 2001). The research by Field and her colleagues appears to show that massage can not only make you feel better, but it can also raise the level of your body’s ability to fight off the effects of disease.

You may be surprised to know that until about 35 years ago, many physicians and scientists believed infants were insensitive to pain. Read Journey of Research: Do Infants Feel Pain? to find out the history of these ideas.

**JOURNEY OF RESEARCH  Do Infants Feel Pain?**

Strange as it may sound, until the 1980s, many physicians believed that infants did not feel pain. Because doctors also knew that anesthesia can have negative side effects, particularly for the smallest patients, they concluded it was best to use little or no anesthesia during painful medical procedures. The best-known case is that of an infant named Jeffrey Lawson who was born prematurely with a defect to his heart. He underwent open heart surgery with medicine designed to paralyze him during the surgery, but with no pain medication (Rodkey & Pillai Riddell, 2013).

Where did this idea come from? In a series of experiments on infant sensitivity to pain conducted in 1873, Alfred Genzmer pricked premature infants with pins, often causing blood to flow. (This would not meet current ethical standards for research!) Genzmer reported the infants showed no evidence of pain, even though their eyes grew wet (Rodkey & Pillai Riddell, 2013). In experiments conducted in the 1920s, infants between a few hours and 12 days of age were stuck with needles on their cheeks, thighs, and calves (Chamberlain, 1999). Almost all the infants cried, regardless of their age, but the oldest cried more in response to the mildest stimuli than the youngest did to the most painful stimuli. Based on this observation, the researchers concluded that the youngest infants in their study were relatively imperious to pain, while the older infants had become more sensitive. What they failed to take into account, however, was that mothers then were routinely given anesthesia during delivery. It is likely the maternal anesthesia was still in the systems of the youngest infants at the time they were tested, and these effects wore off gradually over the first few days of life.

Similar experiments were conducted in the 1930s by Myrtle McGraw, who reported on research in which infants from birth through 4 years of age were pricked with a pin. She reported that some infants did not respond to the pin pricks, but she also noted that others tried to pull away and cried. However, she concluded that these infant reactions were local reflexes that did not reach the higher levels of brain function, implying again that infants do not experience pain the way older children and adults do. Over the years, McGraw’s speculations about brain function came to be cited as real evidence that brain immaturity was the reason infants were insensitive to pain.

In reading about this research, you may be wondering how these scientists could so badly misinterpret what they were seeing. Wasn’t it obvious to them that sticking a pin in an infant was painful and made the infant cry? In the 1980s, research finally joined with parent advocacy to reach the conclusion that infants do experience pain. Owens and Todt (1984) found “that the increases in heart rate and crying in the context of a tissue damaging stimulus indicated that the infants experienced pain and that pain in infants can be reliably measured in clinical settings” (p. 77). The earlier research—and the misguided interpretation of its results—reminds us how careful we must be not to let our initial beliefs

**T/F #6**

**Within the first 2 months of life, infants do not experience pain.**

*false*
override the evidence that is right in front of us. When we observe an infant undergoing a medical procedure and crying, furrowing his brows, struggling and squirming, or breathing heavily while his heart races, we should accept the logical conclusion that the infant is in pain, not assume infants do not experience pain because others have said so.

The most common surgical procedure for infants is circumcision, removal of the foreskin from the penis, usually performed within the first 10 days after birth (Taddio, 2001). About 77% of male infants in the United States are circumcised, which is a decrease from 83% in the 1960s (Morris, Bailis, & Wiswell, 2014). Non-Hispanic White males are most likely to be circumcised (91%), followed by non-Hispanic Black males (76%) and Mexican American males (44%) (Morris et al., 2014). For many families, it is part of a cultural tradition, but for others it is a personal choice. Because circumcision is a painful procedure, many parents weigh its pros and cons before deciding whether to circumcise their baby boys. However, the American Academy of Pediatrics has supported circumcision as a procedure whose benefits outweigh its risks. The health risks associated with neonatal circumcision are very small while the risks associated with not circumcising an infant include higher rates of urinary tract infections, HIV, and a number of other conditions for the male and increased rates of cervical cancer, chlamydia, and other conditions for any female sexual partner (Morris et al., 2014). Pain control is very important during circumcision and can include a variety of local anesthetics as well as stress reducers such as use of a pacifier dipped in sucrose (Taddio, 2001).

**Cross-Modal Transfer of Perception**

So far we have described how infants perceive the world through their individual senses. However, the senses also have to work together. For example, if you closed your eyes and touched an apple, when you opened them and someone showed you an apple and an orange, you would know you had just touched the apple by looking at it. In other words, your perception of “apple” crosses from the tactile mode to the visual mode because your senses work together in a process called cross-modal transfer of perception.

Infants, even from birth, show some aspects of cross-modal transfer of perception, but their abilities are limited in a number of ways. They can visually recognize something they have only touched and not seen (like the apple in the example above), but they cannot recognize by touch something they have only seen but not touched (Sann & Sterri, 2007). These abilities strengthen as infants grow older and have more experience seeing, touching, hearing, smelling, and tasting many things in their world.

Many toys designed for young children incorporate features that let them use their senses to explore the world. **Active Learning: How Toys Stimulate Babies’ Senses** helps you identify some of these features for yourself in a popular infant’s toy.

---

**Active Learning**

**How Toys Stimulate Babies’ Senses**

Given what you now know about infant sensory preferences, think about how toys you have seen are designed to promote infant sensory development. For example, the toy shown here can be held by any of the handles, all of which have different textures. When a baby shakes it, it makes a soft chiming sound. The faces will attract babies’ attention. Now use what you know to design your own baby toy. Describe how each feature of your toy can foster development of the baby’s senses.

---

*Circumcision* Surgical removal of the foreskin of the penis.
Sensory Preferences and Connection to Caregivers

To review, we have seen that infants prefer to look at faces, naturally “look you in the eye,” recognize their mother’s voice, and prefer her scent and the taste of her milk. In addition, infants are able to naturally imitate people from their first days of life. Clearly, from the minute we are born we are well equipped to enter a social world, and we are prepared to form relationships with those who take care of us. Although true attachment will not develop until later in the first year of life, as we discuss in Chapter 7, infants prefer the special people who care for them, and they have inborn mechanisms that draw these people into relationships with them.

Check Your Understanding

1. What are sensations, and how do they differ from perceptions?
2. How do each of the senses develop during infancy?
3. How do infant sensory preferences connect infants to their caregivers?

Infant Body Growth and Motor Development

Of course all babies are beautiful, but beyond that they share some physical characteristics that draw us to them. In this section, we discuss the proportions and growth of the normally developing infant’s body. We then describe the ways in which babies develop their motor skills, from the earliest reflexes to the ability to walk and manipulate objects.

Infant Bodily Proportions

When infants are born, the comparative proportions of their heads and bodies are very different from those of older children and adults. A baby’s head is very large in comparison to his small, helpless-looking body. If you do the activity described in Active Learning: Head-to-Body Proportions with an infant or toddler, you will see for yourself how short the child’s arms are in comparison to the size of her head.

Active Learning

Head-to-Body Proportions

Take your right hand and reach over your head to touch your left ear. No problem, right? Now ask the parent or caregiver of an infant or toddler to help the child do the same thing. How far does the child’s hand get over her head? Most likely the child’s arm will not reach the opposite ear because her head is much larger in relationship to the rest of her body than the head of an adult is to his body.

As children mature, their arms and legs lengthen, and the rest of the body catches up in size to the head. The ability to reach overhead and touch your opposite ear has been used in some countries, such as Tanzania where there were inadequate birth records to document children’s ages, as a rough test of a child’s maturation and readiness to attend school (Beasley et al., 2000).

In addition to their large head, infants also have large eyes, a small nose and mouth, and relatively fat cheeks. There may be an evolutionary reason
On these growth charts, the line marked “50” represents the growth of the average child. Half the children at any given age are above that average and half are below. The other lines represent the growth of children above or below the average. For example, children who fall on the line marked “90” are taller or heavier than 90% of the children of that age.
for this appearance. It makes babies appear cute, and we are attracted to taking care of them (Vance, 2007). This attraction is even stronger for women who have larger amounts of reproductive hormones in their system (Sprengelmeyer et al., 2009). A secret few parents will reveal is that some aspects of baby care can be unpleasant because they include dealing with all kinds of bodily fluids, smells, and being up half the night, but as a new mother once wrote: “It’s a good thing God made babies so cute, otherwise you would send them right back to the hospital!” Anyone who has seen the movie E.T. (Spielberg, 1982) knows that in spite of how frightening the extraterrestrial in the title looked, with his large head, large eyes, and helpless-looking body, we loved him and wanted to help him get home again. In the same way, we protect and nurture our babies in spite of the difficulties of caring for them, and this is in part because of the effect their bodily proportions have on us.

Growth from infancy to age 2 is very rapid. The average infant doubles her birth weight by about 5 months of age and triples it by her first birthday. During this same time, she will add about 10 inches or 50% to her length at birth. If the same rate of growth applied to the average 11- or 12-year-old, it would be terrifying, but after a child’s second birthday, growth slows. Two-year-olds are approximately half the height they will be in adulthood, so to get an estimate of a child’s adult height, you can double the child’s height at age 2. However, a better indicator is to look at the height of family members. Assuming adequate nutrition, height is highly genetic, so it is very likely a child’s eventual height will fall somewhere within the range of the height of her close relatives.

Figure 5.5 shows average growth rates for boys and girls. Despite the smooth curve of growth, real growth may occur in spurts. In fact, infant sleep patterns have been found to predict these growth spurts. If babies begin to sleep longer or take more naps, they may be about to have a jump in both height and weight (Lampl & Johnson, 2011).

Motor Development
In the following section we examine the development of motor skills. We begin with a description of babies’ first movements: the reflexes. We then describe the role the myelination of the nervous system plays in determining the sequence in which motor milestones are achieved. Finally, we discuss other factors, such as physical activity, that influence the development of early motor skills.

Infant Reflexes
Newborns can’t move around on their own, and they don’t have much control over their limbs, but from the time they are born, they have a set of involuntary, patterned motor responses called reflexes that are controlled by the lower brain centers and that help them respond to some of the stimuli in the environment. These reflexes are hardwired into the newborn’s nervous system, so they are automatic and don’t need to be learned. Within the first few months of life, the higher centers of the brain develop and take over from the lower centers. As this happens, most of the infant reflexes disappear on a predictable timetable and are replaced by voluntary and intentional actions. Table 5.3 lists many of the infant reflexes and shows when they usually disappear. For instance, if you gently touch a newborn’s cheek, she will reflexively turn in the direction of the touch to find a source of food. It doesn’t take very long, however, for even a young infant to learn the signals indicating she is about to be fed. At that point, she will begin to turn in the direction of her caregiver as soon as she recognizes it is mealtime, but now with a voluntary action. Reflexes that have survival value persist beyond infancy.

It is not that reflexes and voluntary behavior are two distinct types of response. There is a continuum that represents different mixes of reflexive and voluntary behavior that we see as motor development proceeds (Anderson, Roth, & Campos, 2005). However, if a reflex is missing or fails to disappear when it should, this can be an indication of a neurological problem and the infant should be assessed by a doctor.
Infants begin moving even before birth, exercising their developing muscles and giving feedback to the motor cortex of the brain that helps develop voluntary movements after birth (Eliot, 1999). Although the fetus cannot voluntarily control its movements, we can see prenatal ultrasound pictures of babies sucking their thumb. It appears that some kind of reflexive behavior may result in the fetus “finding” its thumb (Becher, 2006). Interestingly, the preference for one thumb or the other is predictive of whether the child later will be right-handed or left-handed (Hepper, Wells, & Lynch, 2005).

### Development of Motor Skills

Two basic forms of motor skills are gross motor and fine motor. **Gross motor skills** call on the large muscle groups of the body (for example, the legs and arms). **Fine motor skills** enable us to make small movements, mostly of the hands and fingers, but also of the lips and tongue. The development of these skills is linked with the development of the brain and the entire nervous system.

The motor cortex is the strip at the top of the brain that goes from ear to ear and controls the conscious motor movements of the body (Bower, 2004). If you were to guess, which parts of the body do you think take up most of the area in the motor cortex? If you guessed the legs, because they are large and...
have so much range of motion, you will be surprised to learn the majority of the motor cortex is used to control the mouth and hands, which contain many more muscles than the legs. Look at Figure 5.6 to see how the body is represented in the brain, both for motor activities and for sensory input. Neuroscientists in England recently found the motor cortex is so complex that it is activated not just when we actually act, for example when we kick something, but also when we read action words, such as *kick* (Bower, 2004).

**Myelination of Motor Neurons**

The brain connects through the spinal cord to all the neurons in the body. As we discussed, the nervous system works more efficiently when it has been coated with the fatty substance known as myelin. This is true not only for the neurons in the brain but also for the motor neurons in the body. The myelin sheath is set down in the nervous system in the body in two directions: from the head downward, referred to as the **cephalocaudal** direction, and from the torso out to the extremities of fingers and toes, referred to as the **proximodistal** direction.

The effects of the cephalocaudal direction of myelination are illustrated in the following photo series.

---

**Gross motor skills** Skills that involve the large muscle groups of the body—for example, the legs and arms.

**Fine motor skills** Skills that involve small movements, mostly of the hands and fingers, but also of the lips and tongue.

**Cephalocaudal** Physical development that proceeds from the head downward through the body.

**Proximodistal** Development that proceeds from the central axis of the body toward the extremities.
1. Head and neck: Parents of newborn infants must be careful to support the baby’s head, but as myelination proceeds downward, babies become able to hold up their head independently.

2. Shoulders: A newborn placed on his stomach will remain in that position, but as myelination moves down the neck, the baby will be able to raise his head to see the world.

3. Shoulders: As the shoulders come under control, the baby will reach the next milestone, rolling over (from stomach to back and from back to stomach).

4. Hips: When the hips and back come under the baby’s control, she can now begin to sit up, at first with support and then independently.

5. Thighs: With control of the legs, babies can pull their legs underneath them and begin to crawl. Often babies will initially crawl backward, in part because their control of their arms is greater than their control of their legs (Greene, 2004).

6. Arms and chest: With control of this region, the baby will be able to use his arms to push up from his stomach to survey a larger area around him. However, his legs are still flat to the floor.

7. Lower legs: With control traveling from the thighs to the lower part of the legs, babies begin to pull up on furniture to a standing position.

8. Feet: Control of the feet is needed to walk independently. At first babies walk with feet wide apart and hands raised to help with balance. As they gain more control of their feet and toes and better balance, their gait becomes more like that of an adult.

The cephalocaudal direction of myelination results in infants gaining control of their bodies in the following sequence that corresponds to the motor milestones that most babies go through and that parents joyfully record in their baby books.
The proximodistal direction of myelination, from the central axis of the body out to the extremities, results in the following steps in development:

1. **Torso:** Babies will roll over, using control of their chest and shoulders.
2. **Arms:** Control of the arms begins with the infants’ ability to swipe at objects they see. They become able to use their arms to push up from the ground, which eventually develops into crawling.
3. **Hands:** When infants begin to purposefully grasp objects, they scoop objects with all their fingers up against their palms, in what is called the palmar grasp.
4. **Fingers:** As they gain control of their fingers, they can use thumb and forefinger to pick up things as small as Cheerios. This is called the pincer grasp. Only later can they control the rest of their fingers to use a tripod grasp, using thumb, forefinger, and middle finger to hold a pencil.

**Variability in Motor Milestones**

The sequence of motor milestones happens in the same way for most babies around the world. This fact indicates that motor development is strongly controlled by our genes, which dictate the expected sequence of development. Thus, we can describe motor development as strongly canalized, as noted in Chapter 3; that is, genes allow for only a few possibilities in response to the environment. However, there is some variation in the timing of motor milestones. For example, although most infants in the United States walk by 12 to 14 months, some walk as early as 9 months and some not until 18 months.
Development may be uneven, so an infant might forge ahead with cognitive development but take longer to develop motor skills. A pediatrician can discuss with parents whether a later onset of walking is of concern for their child or whether it is just a normal variation in development of motor skills.

In addition to individual differences, there are cultural differences in the age at which children begin to walk. These differences are linked to cultural practices and beliefs. For example, Super (1976) found that Kenyan parents practiced walking and sitting skills with their babies, and as a result their babies reached these particular milestones sooner than babies in the United States. In the United States, babies’ stepping reflex typically disappears at about 3 months of age as babies become chunkier and cannot lift their legs as easily. Their muscle development does not keep pace with the weight they add to their legs (Thelen, Fisher, & Ridley-Johnson, 2002). In contrast, the Kenyan babies who exercised their legs did not lose their reflex before they developed real walking. Other activities they did not practice, such as rolling over, did not develop more quickly. Clearly, specific skills developed earlier because these babies practiced them, with the help of their parents.

To test this hypothesis, Zelazo, Zelazo, Cohen, and Zelazo (1993) had Canadian parents practice walking skills or sitting skills with their 6-week-old babies. They found that skill development was quite specific. Those trained in walking were able to walk at an earlier age, while those trained in sitting performed this action at an earlier age. Therefore, even though genes are responsible for the general development of these skills, the environment can affect their fine-tuning. Although this research supports the idea that these motor skills can be advanced by practice, remember that it is not necessary to practice them. Even when a culture’s child-rearing practices do not include “practice walking,” all infants learn to walk given the opportunity and encouragement.

Another example of the effects of experience on the development of motor skills is the Back to Sleep program instituted by the American Academy of Pediatrics. In 1992, this group began to recommend that infants be put to sleep on their backs to reduce the risk of sudden infant death syndrome (SIDS). Since that time, the incidence of SIDS has decreased by more than 50% (National Institute of Child Health and Human Development, 2010). However, there is some evidence that an unintended consequence of this policy is that infants are starting to crawl at later ages (Davis, Moon, Sachs, & Ottolini, 1998). When babies sleep on their stomachs, they reflexively move their arms and legs, strengthening those muscles, but when they sleep on their backs, they do not get this stimulation. As a result, pediatricians and others are now recommending that parents put their infants on their stomachs for some period of time every day while they play with the baby or at least keep a watchful eye to be sure the baby is safe. On the other hand, going directly from sitting to walking is not associated with later motor problems, and infants who sleep on their backs walk at the same age as other infants (Davis et al., 1998). We also have debunked the myth that children not having the experience of crawling later develop learning disabilities. Crawling is has nothing to do with cognitive skills such as reading (Kasbekar, 2013).

**Dynamic Systems**

We have seen that the development of motor skills results from input from genes, maturation, and the environment. However, researcher Esther Thelen, whose dynamic systems theory we described in Chapter 2, has shown that development of motor skills is even more complex. For example, newborns are unable to control the movements of their arms to reach for something, and it was assumed that the development of eye-hand control is the necessary factor for achieving this control. But Thelen and her colleagues were able to show that the infant’s activity level is another major factor. Infants have to control the speed with which they move their arm to successfully grasp a desired object,
so those who are more active have to learn to slow down and control their reach, while those who are less active have to increase the velocity of their reach to be successful (Thelen et al., 1993). Infants need to find the best fit between their physical style and the demands of the task. In the human dynamic system, many factors, including physical, cognitive, and social factors, must come together to determine all behaviors.

Although research is showing the complexity of motor development, the real-world approach to fostering early motor skills remains simple. Parents can promote normal development of motor skills by providing a safe, babyproofed space that is large enough for infants and toddlers to explore and by enthusiastically encouraging the development of each motor milestone in its turn. Under these conditions, over the course of a normal waking day, when infants begin walking, they will take more than 9,000 steps, the equivalent of the length of 29 football fields (Adolph & Berger, 2006).

You can learn more about the development of motor skills in infants and toddlers by carrying out Active Learning: Checklist of Motor Skill Development with a child.

Active Learning
Checklist of Motor Skill Development

The following checklist of motor skills from the National Center for Education in Maternal and Child Health shows you what to expect an average or typical infant to do with regard to gross motor skill development. You can use it to observe an infant or toddler under 2 years of age to see how the child’s ability corresponds to what is average or typical. There is a great deal of variability between individuals, however, so any individual infant may not do everything expected at a particular age but still be developing within the normal range.

<table>
<thead>
<tr>
<th>Motor Skill</th>
<th>Mean</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holds head erect and steady</td>
<td>1.6 months</td>
<td>0.7–4 months</td>
</tr>
<tr>
<td>Sits with support</td>
<td>2.3 months</td>
<td>1–5 months</td>
</tr>
<tr>
<td>Lifts head, shoulders, and forearms while lying down</td>
<td>3.5 months</td>
<td>2–4.5 months</td>
</tr>
<tr>
<td>Sits momentarily without support</td>
<td>5.3 months</td>
<td>4–8 months</td>
</tr>
<tr>
<td>Reaches with one hand</td>
<td>5.4 months</td>
<td>4–8 months</td>
</tr>
<tr>
<td>Rolls over from back to front</td>
<td>6.4 months</td>
<td>4–10 months</td>
</tr>
<tr>
<td>Crawls and pulls on objects to achieve upright position</td>
<td>8.1 months</td>
<td>5–12 months</td>
</tr>
<tr>
<td>Walks with handholds (“cruises”)</td>
<td>8.8 months</td>
<td>6–12 months</td>
</tr>
<tr>
<td>Stands momentarily without support</td>
<td>11 months</td>
<td>9–16 months</td>
</tr>
<tr>
<td>Walks independently</td>
<td>11.7 months</td>
<td>9–16 months</td>
</tr>
</tbody>
</table>


Were you surprised by any of the actions the child you observed could or could not perform? How would you explain the upper limits of the child’s abilities—lack of practice, level of brain maturation, development of motor coordination, or other reasons? If you were able to compare your observations with those of other people, did you find trends of physical development across ages, and did you find individual differences between children of the same age?
Effects of Motor Skill Development

The timing of motor milestones interacts with other areas of infant development. In a classic work, Eleanor Gibson developed what she called the visual cliff, a Plexiglas-covered table that gives the illusion that one side drops off from table level to floor level as shown in Figure 5.7 (Gibson & Walk, 1960). Although babies can perceive depth from an early age, Gibson’s research showed they do not develop a fear of sudden “drop-offs” until they have started to crawl. About 4 to 6 weeks after they have learned to crawl, they become fearful of what looks to them like a fall about to happen (Campos, Bertenthal, & Kermoian, 1992). The new ability to move around has other effects as well. Infants can now try to stay near their parents as attachment develops; but they also can explore more freely, which increases learning; and they can also get into more trouble, which requires more control from parents and others (Campos, Kermoian, & Zumbahlen, 1992).

Bladder and Bowel Control

Like all motor skill development, the progress children make with regard to toilet training not only is dependent on their physical ability to control their bladder and bowel muscles, but also on their cognitive, social, and emotional development. This development takes place within a cultural context that reflects wide differences in the expectations for and even the definition of toilet training. In the United States, young toddlers often begin potty training between 18 and 24 months of age. Caucasian families generally begin training later (about 23 months) than non-Caucasian families (18–19 months) (Horn, Brenner, Rao, & Cheng, 2006). In contrast, in other countries, infants are trained to have some control over elimination during the first year of life. In Vietnam, infants usually
do not wear diapers and parents are alert to signs their baby needs to pass urine or have a bowel movement. Vietnamese mothers report that when the infant passes urine the parent makes a whistling sound, and the infant soon becomes conditioned to urinate when hearing the sound. As a result of this type of training, infants are capable of remaining dry with parental support by a year of age (Duong, Jansson, & Hellström, 2013).

In the United States and other Western societies, infants do wear diapers and potty training takes place in a very different way. Rather than using parents’ observations of when the child seems to need to urinate or defecate, a child-centered approach relies on signs that the child is ready for training to begin. They are:

- The child stays dry at least 2 hours at a time during the day or is dry after naps.
- Bowel movements become regular and predictable.
- The child can follow simple instructions.
- The child can walk to and from the bathroom and help undress.
- The child seems uncomfortable with soiled diapers and wants to be changed.
- The child asks to use the toilet or potty chair.
- The child asks to wear “big-kid” underwear. (American Academy of Pediatrics [AAP], 2009a)

In the process of potty training, parents need to decide what words they will use for body parts and for urine and feces. They may use a child-sized potty chair. The child may begin by telling the parent when she has a dirty or wet diaper. Parents can make regular use of the potty as a part of the child’s routine. When the child achieves a level of dryness, training pants can be introduced (AAP, 2009a). However, the child should never be shamed for having accidents. For many parents potty training is a time for encouraging and rewarding the child’s attempt to master this new skill. The more parents can treat this as a learning process and less as a battle of wills, the better off everyone will be. The goal for this approach is a child who can independently use the bathroom without parental help.

Check Your Understanding

1. What reflexes does an infant possess?
2. What is the difference between gross motor skills and fine motor skills?
3. How do motor skills develop as the process of myelination proceeds?

Health and Nutrition

In this section, we discuss how to get babies off to a healthy start, as well as some of the risks to health that may affect infants.

Breastfeeding

The American Academy of Pediatrics Section on Breastfeeding (2005) describes human breast milk as “uniquely superior for infant feeding” (p. 496) and recommends that babies be exclusively breastfed until 6 months of age, with other foods gradually added between 6 months and 1 year. In 2010, about 77% of new mothers in the United States began breastfeeding their babies, about 49% were still doing so when the babies were...
6 months old, and 27% continued to breastfeed at one year of age (CDC, 2013i). This is a significant improvement; rates in 2000 were 71% breastfeeding at birth, 35% at 6 months, and 16% at 12 months (CDC, 2013i). Women who are more likely to breastfeed are older, have more education, are married, and live in metropolitan areas (Li, Darling, Maurice, Barker, & Grummer-Strawn, 2005). Serious questions have been raised about how well hospitals, places of work, and other institutions support a woman's decision to breastfeed her infant (Gartner et al., 2005; Lindberg, 1996; Skafida, 2012). For example, the rate of breastfeeding might be improved if workplaces provided private settings for mothers to pump milk for their babies or if hospitals did not give new mothers free samples of formula provided by the companies that produce them.

Breastfeeding offers benefits to both the baby and the mother. Breast milk provides the baby with antibodies that come from the mother's body and help fight off infection. In both developed and developing countries, breastfeeding is associated with a decreased incidence and/or severity of infectious diseases such as diarrhea, respiratory infections, and ear infections (Gartner et al., 2005). There is some evidence that breastfeeding promotes earlier development of the infant's own immune system (Jackson & Nazar, 2006). Other benefits include lower rates of type 2 diabetes and lower rates of SIDS (CDC, Division of Nutrition and Physical Activity, 2007). There is even some indication that breastfeeding may help prevent childhood and adolescent obesity, although more evidence is needed to prove this conclusively (CDC, Division of Nutrition and Physical Activity, 2007; Dewey, 2003; von Kries et al., 1999). In some studies, breastfeeding has even been associated with slightly enhanced performance on tests of cognitive development and brain development (Gartner et al., 2005; Isaacs et al., 2010). However, this research must be interpreted with some caution. Because mothers who choose to breastfeed their infants tend to be older and have more education than those who don't, we need to be sure we have taken maternal differences into account before attributing the cognitive advantage only to the decision to breastfeed. These other maternal characteristics would have a positive influence on cognitive development on their own (Der, Batty, & Deary, 2006).

For the mother, production of breast milk is related to production of the chemical oxytocin, which helps her uterus return to shape. Although this chemical also delays the return of fertility, women are advised not to rely exclusively on breastfeeding to prevent another pregnancy. Lactation also appears to make mothers more relaxed and less reactive to stress, possibly by reducing blood pressure (Light et al., 2000; Tu, Lupien, & Walker, 2005). In the long term, it has been found that women who breastfeed have a reduced risk of some breast and ovarian cancers and type 2 diabetes (Gartner et al., 2005; Ip et al., 2007).

Breastfeeding also benefits the individual family and society as a whole. It has been calculated that increasing the rate of breastfeeding in the United States to the level recommended by the Surgeon General would save a minimum of $3.6 billion through lower health care costs and less loss of wages caused by caring for a sick child (Weimer, 2001). Additional benefits are that the family does not have to pay for formula, and society does not need to deal with the disposal of formula cans and bottles and the cost of transporting these products to market.

In certain rare circumstances breastfeeding is not recommended. You learned in Chapter 4 that HIV can be transmitted from an infected mother to her infant through breast milk, so HIV-positive mothers should not breastfeed. Most drugs prescribed by a physician are not likely to be harmful to the infant, but when a woman is undergoing
chemotherapy or using antibiotics, antianxiety medications, or antidepressants, these substances enter her breast milk (American Academy of Pediatrics Committee on Drugs, 2001). For this reason, women should consult with their doctor concerning the safety of any medication they are taking. Because nursing women who smoke have nicotine in their breast milk, this is another good reason to give up smoking (Gartner et al., 2005).

**Caring for Teeth**

Babies are usually born toothless, although about 1 in every 2,000 to 3,000 newborns have what is called a natal tooth that has very little root structure and is usually removed before the baby leaves the hospital (Fotek, 2012). When a baby is born, 20 baby teeth are already almost entirely formed below the gums, and these teeth begin to emerge when an infant is between 6 and 9 months old (American Dental Association [ADA], 2005). Figure 5.8 illustrates the usual order in which teeth emerge during the first 2½ years. Generally, the central bottom teeth come in first, followed by other teeth near the center of the mouth, and then those to the side of the central teeth. Teething is often rather uncomfortable for babies and may cause fussiness. Sore gums can be soothed by a massage with a clean finger, or by a chilled teething ring to chew on. A physician may prescribe an anti-inflammatory medication if the pain is not controlled in those ways.

Even though baby teeth will eventually fall out and be replaced by permanent teeth, they should receive good care, since they are important both for eating and for learning.

**FIGURE 5.8 Baby teeth**

Baby teeth usually emerge in the order and at the ages shown
to talk (ADA, 2005). Tooth decay in baby teeth can lead to infection that can damage the permanent teeth growing in the gums. The American Dental Association (2005) recommends that a caregiver begin brushing the child’s very first tooth with a little water and infants should not sleep with a bottle in their mouth, because the milk or juice stays on the teeth for a long time, promoting tooth decay. Finally, limiting sweets is important for everyone’s dental health, but it is especially important for infants.

**Starting Solid Foods**

As we’ve seen, the American Academy of Pediatrics recommends waiting to offer babies solid food until they are 6 months old. However, 40% of parents give their babies solids before even 4 months of age (Clayton, Li, Perrine, & Scanlon, 2013). In one study, mothers reported doing so because they thought the baby was old enough or because they thought solid foods would help the baby sleep through the night, although this appears to be a myth with no evidence to support it (Zero to Three, 2012). Many said their doctor had told them to start, indicating many pediatricians are not following the AAP guidelines.

Mothers who introduced solid food early were more likely to be young, single, and with a lower level of education. Mothers who were feeding the baby with formula rather than breastfeeding also tended to introduce solids earlier (Clayton et al., 2013). For some families the high cost of formula was a reason for introducing solid food (Quenqua, 2013). Babies who were more irritable also were more likely to receive solid food early (Wasser et al., 2011). Babies get all the nutrients they need in the right proportions from either breast milk or formula, so introducing solid foods too early often means the baby won’t drink enough milk to get the balanced nutrition it offers. Figure 5.9 shows the types of foods infants are being fed at different ages during the first year of life.

**Nutrition and Malnutrition**

A national study in which parents in the U.S. reported on what their infants’ and toddlers’ ate found that most are eating a healthy diet. In 2008, infants were more likely to...
Part III  Infancy and Toddlerhood

170

be receiving breast milk and less likely to be receiving formula than in 2002. They were eating more fruits and vegetables and fewer desserts, sweetened drinks, and salty foods than 6 years earlier. However, many were still not receiving enough fiber, which comes from fruit, vegetables, legumes, and whole grains and were receiving too much salt and saturated fat. All these are risk factors for heart disease and high cholesterol later in life (Butte et al., 2010).

Obviously malnutrition is an even greater risk for infant development than a poor diet. An estimated 19 million children in developing countries suffer from severe malnutrition, and the younger the child is, the more vulnerable she is to the effects of malnutrition on growth (Management of Acute Malnutrition in Infants (MAMI) Project, 2009). Being malnourished is not just going hungry; it means not getting the nutrients needed for growth and development. This affects brain development as well as other aspects of physical health and growth. If the infant survives malnourishment, and many do not, the effects may last a lifetime even if the person later gets plenty of food. In a study in Barbados, adults who had been malnourished as infants were more likely to have ongoing attention deficit and conduct problems that began in childhood and continued through adulthood (Galler et al., 2012a; Galler et al., 2012b). It is essential that infants receive adequate nutrition; otherwise, the results of the early assault on their growth and development become irreversible.

Sleep

Newborns sleep a total of 16 to 18 hours per day (Hanrahan, 2006). By 6 months of age, most will sleep through the night for 12 hours or more and continue to take daytime naps (Hanrahan, 2006). Figure 5.10 shows how sleep patterns typically change over the first 2 years of life.

About one-third of babies do not sleep through the night until much later than 6 months. There is much controversy about how parents should deal with infants who awaken during the night. Some say they should be attended to whenever they cry, and many parents are comfortable doing so, but some parents may find themselves exhausted during the day because their baby continues to get up one or more times during the night. Exhaustion can lead to depression, which interferes with effective parenting, so addressing sleep issues for baby and parent is very important (Martin, Hiscock, Hardy, Davey, & Wake, 2007).

In one experimental study in Australia, parents who reported that their infants had sleep problems were assigned to either a sleep education program or a control group. In the sleep education program, parents were taught about normal infant sleep cycles and learned that infants older than 6 months of age can be taught to settle back to sleep on their own without a parent soothing them. Parents were taught to respond to infant crying at night at increasing intervals of time until the infant learned to go back to sleep without parental help. The families were also advised to gradually reduce the number of times infants were fed during the night. After two months, infants in the intervention group had greater reduction in sleep problems, and mothers in the intervention group who were depressed had a greater decrease in depression (Hiscock & Wake, 2002).

Some parents fear that allowing their baby to cry at night may be harmful, and there is some evidence that simply allowing the baby to “cry it out” alone for the whole night is stressful and should be avoided. However, in a follow-up study of those infants who
received the more gradual approach described above, no detriment was found at age 6 in the child's emotional development, security of attachment to the parents, or any aspects of psychosocial functioning the researchers examined (Price, Wake, Ukoumunne, & Hiscock, 2012).

Illnesses and Injuries: Prevention and Care

So far we have discussed the basic issues of health, including nutrition and sleep. We now examine the more medical issues of vaccinations to prevent illness and some of the threats to infants' health such as illness, abuse, and stress.

Vaccinations

Vaccinations are an important way to prevent illness. Not vaccinating a child puts both the child and those around the child at greater risk of contracting preventable diseases. In 2010, there were more cases of whooping cough (pertussis) reported in California than in any year since 1947. When researchers examined the location of these outbreaks, they found children were more than twice as likely to get whooping cough if they lived in areas where large numbers of parents had refused to have their infants vaccinated for this disease (Atwell et al., 2013). Whooping cough causes severe and prolonged coughing in infants, along with apnea, or periods when the baby stops breathing. Half of infants who get this disease are hospitalized (CDC, 2013f). Any small risk that might result from a vaccination is far outweighed by the risk of getting any of the serious diseases that vaccines help prevent.

Common Illnesses and Injuries

As important as immunizations are, they cannot protect against common illnesses, and it is not unusual for infants to develop these illnesses. Because infants are not able to tell us what they are feeling, adults have an extra obligation to watch for and correctly interpret symptoms of illness when they occur.
in young children, and to learn when these require medical attention. Frequent well-baby checkups during the first year of an infant's life give a doctor the chance to monitor the infant’s physical growth and weight gain and are excellent opportunities for parents to ask health-related questions. The American Academy of Pediatrics (2009b) recommends checkups every 3 to 6 months between ages 1 and 3, and on a yearly basis thereafter.

Fortunately, most common childhood illnesses are self-limiting (that is, they resolve without needing any medical intervention), but when a symptom is severe or long lasting, parents need to consult a physician. Any temperature of 105º or higher taken with an oral thermometer requires immediate medical attention because it can be life-threatening, but even a low-grade fever can be a medical concern for infants and young children because it could be a sign of a serious infection.

Ear infections are another common childhood illness. Three out of four children will have at least one ear infection before their third birthday, and this is the most common reason for taking a young child to a physician (U.S. National Library of Medicine, 2013). Ear infections occur when fluid builds up behind the eardrum and becomes a breeding ground for viruses or bacteria (Mayo Clinic Staff, 2008). Bacterial infections will respond to antibiotics, but in most cases this is not necessary. Warm compresses may give the child some relief from pain without overusing antibiotics. However, repeated ear infections become a concern because they can affect a child’s hearing and interfere with the ability to learn language (Shapiro, Hurry, Masterson, Wydell, & Doctor, 2009). When infections become chronic and begin to pose this type of threat, doctors can perform surgery in which tubes are placed in the ears to keep the fluids from building up to restore hearing so language can develop normally (Kogan, Overpeck, Hoffman, & Casselbrant, 2000).

Falls account for over 50% of injuries to children under the age of 1, and they are the number-one reason for visits to the emergency room in this age group (CDC, 2008; 2013e). Infants should never be left unattended on a high surface because you never know when the baby will start rolling over. As infants become mobile, it is essential to take safety precautions to protect them from falls down stairs by installing a safety gate at the top of the stairway. Baby walkers are linked with many accidents because toddlers take off in them without control at 3 feet per second, faster than parents can catch them (AAP, 2008). Although walkers have been redesigned so they are too wide to go through most doorways (or down the stairs), the American Academy of Pediatrics (2002) still recommends that parents avoid them and use a stationary activity center instead. Many parents have the mistaken idea that baby walkers encourage the development of walking, but infants sitting in walkers are not really practicing the skills needed to walk, such as balance. The bottom line is that walkers are very dangerous and babies who use them do not walk any earlier than others.

**Infant Mortality**

In general, developed countries have far lower rates of infant mortality, deaths within the first year of life, than less developed countries. However, even developed countries vary in how effectively they prevent infant death. Figure 5.11 shows the infant mortality rates for a number of developed countries. Note where the United States ranks in this figure. Despite its wealth and the availability of (but not always access to) world-class medical facilities, in 2010 the United States had a higher infant mortality rate than 34 other industrialized countries (Organisation for Economic Co-operation and Development, 2012).

In the United States, an average of 6.1 babies of 1,000 live births die within the first year; the precise rates vary significantly by race. In 2009, the infant mortality rate for non-Hispanic Black women was 12.4 deaths per 1,000 live births, compared to 5.33 deaths for non-Hispanic Whites (MacDorman, 2013). The difference was largely attributable to the large number of premature births to non-Hispanic Black women (18.3%). As you know from Chapter 4, premature infants are at far greater risk of not surviving infancy.
However, there is some good news for the United States. Between 2005 and 2011, the infant mortality rate decreased by 12%, with the largest decreases among the highest-risk group, non-Hispanic Black infants (MacDorman, Hoyert, & Mathews, 2013). Although the biggest decreases occurred in southern states, the South still continues to have the highest levels of infant mortality, as shown in Figure 5.12.

The major causes of infant mortality, including birth defects, prematurity/low birth weight, Sudden Infant Death Syndrome, and maternal complications of pregnancy, declined in recent years, but there was no decrease in unintentional injuries (Borse et al., 2008; MacDorman, Hoyert, & Mathews, 2013). Suffocation most often occurs for infants while they are sleeping, so it is important to provide a firm surface free of loose bedding or soft objects, especially for very young infants. For toddlers, suffocation is most often a result of what they put in their mouths: food that is not cut up well enough or other small objects (CDC, 2012i). It is important to babyproof the home to keep these types of objects out of young children’s reach.

**Sudden Infant Death Syndrome (SIDS)**

The unexpected death of an apparently healthy infant is a parent’s worst nightmare. Sudden infant death syndrome (SIDS) is the leading cause of death for children between the ages of 1 month and 1 year (Task Force on Sudden Infant Death Syndrome, 2011). It rarely occurs before 1 month and peaks between 1 and 4 months (Task Force on Sudden Infant Death Syndrome, 2011).

We do not understand the cause of SIDS, but it is likely to be a combination of factors including a physical vulnerability in the infant (for example, some abnormality in the part of the brain that controls breathing, a brain chemical imbalance, a bacterial infection), a stressor in the environment (such as secondhand smoke, overheating due to too much clothing or an overly warm room), and a critical period of vulnerability in early development (Mayo Clinic Staff, 2009).

Because the list of risk factors for SIDS is quite long and not all of them are under parents’ control, it may seem there is little a concerned parent can do, but in fact a couple of preventive strategies are both simple and effective. Putting an infant down to sleep on his or her back has done a great deal to reduce the incidence of SIDS (AAP, 2005).
Of course, once babies can roll over on their own and lift their heads voluntarily to avoid anything blocking their air supply, the position in which they are put to sleep is less important. Other simple but effective precautions are to use a firm mattress for the infant and forbid smoking in the home. Maternal smoking during pregnancy or after the baby is born significantly increases the risk of SIDS. While these precautions do not guarantee an infant will be safe, they are easy ways to lower an infant’s risk.

Abusive Head Trauma and Shaken Baby Syndrome

Sometimes an adult who is frustrated with a baby may shake the baby hard. This causes the baby’s brain to bounce against the skull, particularly if the baby’s head hits something, even an object as soft as a pillow. The damage caused can include bruising, bleeding, or swelling in the brain resulting in permanent brain damage or even death. In addition, because babies’ heads are large in proportion to their bodies and their neck muscles are weak, they may suffer whiplash, much like what you might experience in a car accident. Symptoms of shaken baby syndrome may include:

- Convulsions (seizures)
- Decreased alertness
- Extreme irritability or other changes in behavior
- Lethargy, sleepiness, not smiling
- Loss of consciousness
- Loss of vision

The rate of infant deaths varies by region of the country, with the highest rates in the South.

• No breathing
• Pale or bluish skin
• Poor feeding, lack of appetite
• Vomiting (Kaneshiro & Zieve, 2011)

Within the first 3 months of life, episodes of prolonged crying for no apparent reason are common and normal for infants; however, these times can be very stressful for a new parent. The incidence of shaking by a caregiver is highest when the infant is between 2 and 3 months of age, when this crying is at its peak (Parks, Annest, Hill, & Karch, 2012). It is important for all caregivers to know that although they may feel anger at a baby, they should never act on that anger. Learning techniques for self-control is important to prevent abusive behavior. These may include simply putting the baby down, getting some help with childcare, and expressing emotions to a supportive person. If these feelings of frustration become common, counseling or parenting classes can be helpful. Child abuse hotlines are available for emergency situations.

Stress and Coping

A certain amount of stress is normal for everyone, including infants. For example, many infants experience stress when separated for even a short time from their mother or father. However, for some infants stress is more extreme and may become chronic. This type of stress might be the result of abuse, neglect, hunger, or lack of adequate care.

The stress response is our body’s reaction to experiences we find threatening. Whenever you are exposed to stressful situations, your hypothalamus sends signals to your adrenal gland, which then produces high levels of cortisol, a hormone that prepares your body to deal with threats in the environment by increasing blood pressure and heart rate. Cortisol also shuts down other functions that are not essential at that moment, such as digestion and growth processes (Mayo Clinic Staff, 2013).

Under normal stress, cortisol rises to help deal with the threat and then decreases to let the body return to normal, but when infants experience overwhelming and ongoing stress, their brains become less capable of developing normal mechanisms for responding to stressful situations. The resulting persistent high levels of cortisol can cause brain cells to die or can reduce the connections between areas of the brain that are essential for learning and memory (National Scientific Council on the Developing Child, 2005/2014; Shonkoff & Phillips, 2000).

The neural circuits in the stress response system are particularly malleable during infancy, so prolonged exposure to stressful situations can make these systems overreactive or slow to shut down throughout the remainder of the individual's life. Behaviorally, infants who are under chronic stress may become children and adults who are overly anxious and fearful. Physically, they may produce large amounts of cortisol over a longer period of time. Stress-related production of cortisol is linked with lowered immune responses, so these infants may be more likely to become sick. Cognitive functions are also affected by elevated cortisol, so learning and memory do not develop as well as they would for an infant who experiences a relaxed, organized, and loving environment (National Scientific Council on the Developing Child, 2009). As we’ve learned, infants’ brains are plastic, or changeable, so the good news is that many of the effects of stress early in life can be reversed with sensitive caregiving. However, without intervention, the maladaptive stress response can become a long-term reaction to life experiences that may severely limit the child’s growth and development.

Back to sleep. The “back to sleep” program (the recommendation that parents place an infant on his or her back to sleep) on a firm surface has greatly reduced the incidence of Sudden Infant Death Syndrome in the United States.

Cortisol. A hormone produced as part of the stress response that prepares the body to deal with threat and also shuts down nonessential functions.
Chapter Summary

5.1 What are the structures of the brain and related developmental processes and disabilities?

The brain is made up of neurons and is divided into two specialized hemispheres, connected by the corpus callosum. Although infants have billions of neurons, they have relatively few synapses that connect them. In early brain development, synaptogenesis forms connections between neurons, and myelination improves the efficiency of the neural impulses. Unused synapses are pruned, but when an individual encounters typical experiences, experience-expectant brain development occurs and those synaptic connections are retained. When an individual encounters unique experiences, experience-dependent brain development occurs and new synapses are formed.

Cerebral palsy results from damage to the brain before or shortly after birth and is characterized by problems with body movement and muscle coordination. Autism spectrum disorders may be caused by different patterns of brain development (such as failure to prune unnecessary synapses). Symptoms include impairment in social communication and interaction and restricted or repetitive behaviors, interests, or activities. Severity is classified by how much support the individual needs to function effectively.

5.2 How do the five senses develop in infancy?

Infants are born with a fully functional set of sense organs. Sensations registered by the sense organs are transmitted to the brain and integrated into a coherent picture of the external world in the process of perception. Infants also may automatically imitate simple behaviors they see because mirror neurons in the brain fire in the same way when they see a behavior as when they actually perform it.

Although an infant’s visual acuity is initially poor, it develops to adult levels by 6 months to 3 years after birth. Hearing is well developed at birth, and infants have shown a preference for their mothers’ voices. The sense of smell is highly developed at birth, and infants prefer sweet to other tastes. Both smell and taste preferences are shaped by experiences prenatally. Infants are sensitive to touch. Soothing touch promotes development and well-being while pain produces stress.

5.3 What reflexes and motor skills do infants and toddlers possess?

Infants are born with a set of reflexes, most of which are soon replaced by voluntary movement as the nervous system matures. Children gain control over both fine motor skills and gross motor skills, and these skills develop following the cephalocaudal and proximodistal principles (moving from the head to the tail, and from the center of the body to the extremities).

Motor development is shaped by a complex interaction of genes, maturation, and environmental experiences. Parenting practices can influence how quickly infants develop specific motor skills. Dynamic systems theory makes it clear that motor...
skill development is affected by cognitive and social factors as well as purely physical characteristics.

4.5 What are the major health and nutrition issues in infancy?

Health is promoted in infancy through breastfeeding when possible and development of regular sleeping patterns. Threats to health include colds, fevers, ear infections and injuries from falls. Major causes of infant mortality include SIDS, birth defects, prematurity/low birth weight, maternal complications of pregnancy and unintentional injuries (mostly due to suffocation). Child abuse is also a major risk for infants, including abusive head trauma and shaken baby syndrome. Finally, all infants will experience some amount of stress from everyday events, but in case of overwhelming or ongoing stress the long-term production of cortisol will increase the likelihood of illness, cognitive deficit, and fearfulness.

Key Terms

Autism spectrum disorder (ASD) 000
Axon 000
Cephalocaudal 000
Cerebral palsy 000
Circumcision 000
Corpus callosum 000
Cortisol 000
Cross-modal transfer of perception 000
Dendrites 000
Experience-dependent brain development 000
Experience-expectant brain development 000
Fine motor skills 000
Gross motor skills 000
Hemispheres 000
Infant mortality 000
Mirror neurons 000
Myelination 000
Neurons 000
Neurotransmitters 000
Perception 000
Plasticity 000
Proximodistal 000
Pruning 000
Reflexes 000
Sensations 000
Sudden infant death syndrome (SIDS) 000
Synapse 000
Synaptogenesis 000
Visual acuity 000

Sharpen your skills with SAGE edge at edge.sagepub.com/levinechrono

SAGE edge for students provides a personalized approach to help you accomplish your coursework goals in an easy-to-use learning environment. Go to edge.sagepub.com/levinechrono for additional exercises and video resources. Select Chapter 2, Theory and Research in Development, for chapter-specific activities. All of the Video Links listed in the margins of this chapter are accessible via this site.